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Management of prairie rangeland

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PREFACE

Rangelands are an important resource in the production of livestock. About two-thirds of Canada's beef cattle population is raised on about 85% of the total available rangeland. In addition, about 70% of Canada's seeded pastures are located in the Prairie Provinces and are used for grazing. Therefore, an understanding of the grasslands is paramount to their proper management.

This publication summarizes available information and experience to serve as a guide to proper range management. Recommendations are based primarily on results of experimental studies since 1927 on rangelands and seeded pastures in southern Alberta and Saskatchewan. Much of this information has been published, although additional unpublished information has also been included.

Most of the work reported was conducted at the Lethbridge research substations near Manyberries and Stavely, Alta., and at the Research Station, Swift Current, Sask. Research to increase and maintain the productivity of rangelands and seeded pastures and to increase beef cattle production is being continued at those locations.

This publication can be used as a guide by ranchers, farmers, range technicians, and public-lands managers to maintain high levels of productivity of rangelands and seeded pastures. A list of references is included at the end of the text for those interested in additional information.

CONTENTS

HIGHLIGHTS

- Livestock numbers in the Prairie Provinces reached their average growth potential of 5 700 000 in about 1920. Since then, cattle have largely replaced sheep and horses, and fluctuations in livestock numbers have followed a cyclical pattern influenced by market conditions: on 1 January 1977, the cattle population peaked at 7 700 000 but was down to about 6 750 000 by 1986.

- Grazing pressure has been reduced, from 2.4 ha per animal unit in 1921 to 2.8 ha in 1986, by making more efficient use of rangeland and seeded pastures.

- Some 13 600 000 ha of range and 2 500 000 ha of seeded pasture are used for grazing. The total area includes Parkland and four types of grassland.

- The principles of good range management apply to all vegetative types. These principles may be applied by slightly different practices in different districts.

- The critical periods in range management occur in early spring, when growth is slow, and in the fall, when the crude protein content of vegetation is less than the amount needed by livestock.

- Seeded forage crops are recommended for complementary grazing.

INTRODUCTION

Livestock grazing is one of the main uses of rangeland. The importance of native forage in the production of red meats and other animal products is increasing rapidly as the costs of feed grains and seeded pastures rise.

The management of complex plant communities, such as the prairie rangeland, is concerned with maintaining a balance among species. The balance should be maintained within reasonably narrow limits because, if the balance shifts too far toward undesirable species, it may be difficult to reverse the trend by grazing management alone. Rangeland must also be managed by extensive methods that are ecological, rather than by intensive methods that are agronomic.

The main objective of range management is to maintain the quality of the vegetation and the soil to ensure present and future productivity of the range. An additional objective is to promote plant welfare, because vigorously growing plants yield well and protect the soil. The chief tool of range management is grazing control.

This publication is based on grazing and range vegetation studies and their application to the grasslands and adjacent Parkland of the Prairie Provinces. Relationships among soil, climate, and vegetation and their effect on the growth of grass are discussed.

The spelling of common names of plants is in accordance with the rules in *Common and Botanical Names of Weeds in Canada*, Agriculture Canada Publication 1397.

SOILS AND CLIMATE

The prairie rangeland is an eastward-sloping plain between the Rocky Mountains and the Precambrian Shield. The soils are derived mainly from glacial drift deposited by continental ice sheets. The exceptions include an area in southeastern Alberta and southwestern Saskatchewan, where ancient conglomerates, shales, and sandstones are close to the surface, and regions of limestone outcrop in the Interlake district of Manitoba and in central Saskatchewan.

The main soils of the region are Brown, Dark Brown, Black, Gray Luvisol, and high-lime soils (Fig. 1). Brown soils have developed under semiarid conditions. The surface layer is brown and is relatively low in organic matter and nitrogen, the profiles are shallow, and the limy subsoils are close to the surface. Dark Brown soils have developed under less arid conditions. The surface layer is dark brown, the profiles are thicker, and the soils contain more organic matter and nitrogen than the Brown soils. Black soils have developed under still moister conditions; the surface layer is black and rich in organic

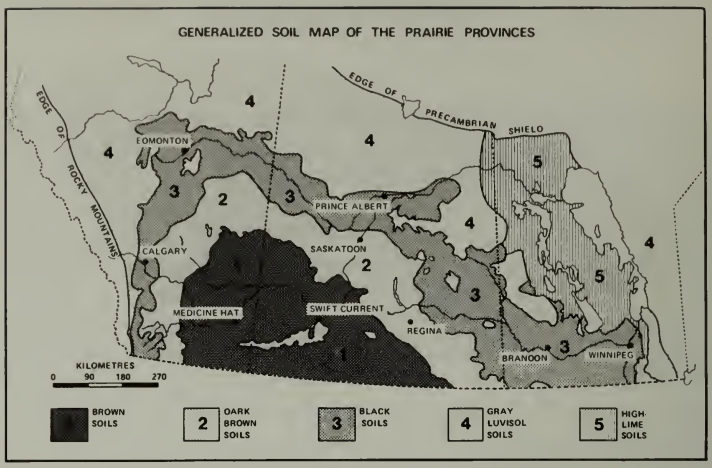

Fig. 1 Generalized soil map of the Prairie Provinces.

matter and nitrogen. The lime layer is usually at depths of 50–75 cm. Gray Luvisol soils occur beyond the Black soils, adjacent to or under a tree cover. Gray Luvisols have an ash-colored, leached surface layer and are low in organic matter and nitrogen. High-lime soils are very shallow, have a high water table, and have developed on extremely limy parent material.

A belt of Solonetzic soils extends across all these soil zones. Solonetzic soils formed from parent material that was high in sodium salts. The subsoil is impervious, and, in some areas, the surface layer has been eroded in patches and has been lost.

Throughout the prairie range, level and moderately rolling tracts of clay, silt, or loam soils are farmed. Steeply rolling areas and eroded, shallow, stony, sandy, or saline soils support native grasses and are used for grazing.

The climate is cool semiarid, merging into cool subhumid in the Parkland. Winters are long and cold, summers are short and warm, and rainfall is low and variable (Table 1).

Long-term precipitation data for three locations are given in Fig. 2. To show trends, the amount of precipitation for each year is the average for that year and the previous 2 years. Fig. 2 shows two points of interest; first, wet and dry years occur in a fairly consistent pattern in all locations. When a drought occurs in one location, conditions are likely to be drier than average in adjacent areas. Therefore, other districts are unlikely to provide extra pasture. Second, years of better-than-average or less-than-average precipitation usually occur in sequence. One wet or dry year affects only the yield, but two or more wet or dry years affect the cover. Drought reduces the abundance of higher-yielding grasses, whereas successive wet years favor their increase. Therefore, the pattern of precipitation causes yields to vary so that forage may either be in short supply or be so plentiful that only a part of the annual growth can be consumed.

The seasonal duration of adequate rainfall also affects the growth of grass. At the border of the prairies, where precipitation is greater, the period is longer during which summer rainfall is more than 50 mm per month (Table 1). This longer growing period gives greater assurance of summer pasture. However, north of the North Saskatchewan River, the main factor limiting crop production is the low summer temperature rather than lack of moisture.

Table 1 Long-term weather records from six locations

Site	Precipitation (mm)		Months with >50 mm rainfall	P:E*
	Mean annual	May–July		
Brandon, Man.	471	201	June–August	1.2
Lacombe, Alta.	443	201	May–August	1.2
Lethbridge, Alta.	423	172	May, June	0.7
Swift Current, Sask.	360	166	June	0.5
Scott, Sask.	351	153	June, July	0.6
Manyberries, Alta.	323	134	June	0.4

* P:E = ratio of precipitation (annual) to evaporation (April–August).

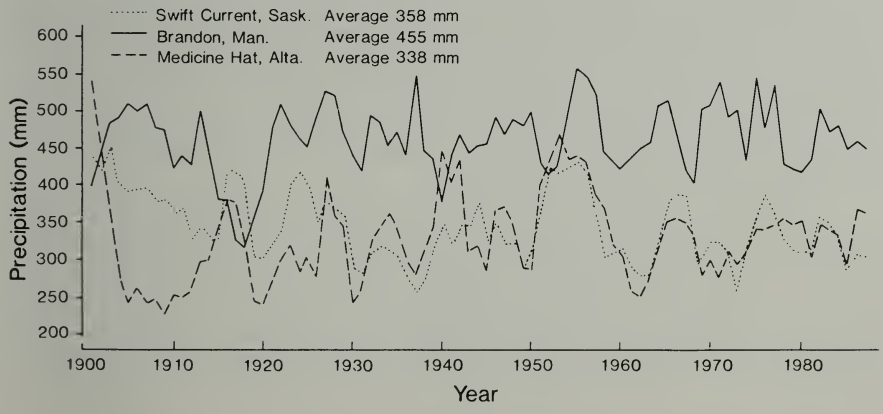

Fig. 2 Average precipitation at three locations in the Prairie Provinces. The amount shown for each year is the average for that year and for the two previous years.

NUMBER OF LIVESTOCK AND SIZE OF PASTURES

Beef cattle on the prairies now number about 6 750 000 (Table 2). The beef cattle population shows two kinds of fluctuations: cyclical and secular. In the early 1900s, cyclical fluctuations occurred at about 16-year intervals, but more recent cycles have been only about 9 years (Fig. 3). Secular, or long-term, trends are upward, and indications are that they likely will continue.

Sheep have never been important on western ranges. In 1944, the number of sheep reached a peak of 1 873 000, but the numbers have decreased steadily ever since. In 1986 sheep numbers were about 257 000 (Table 2).

Horses increased in number until about 1921, when tractors began to replace them on farms and ranches. In 1972, there were 181 000 horses in the Prairie Provinces, the lowest population since about 1892, and they no longer contributed significantly to farm output. By 1986 the number had increased again to about 243 000 horses. Fewer sheep and horses helped make possible the increase in the number of beef cattle (Table 2).

The total number of animal units appears to have stabilized at about 5 700 000 (Fig. 4). Cyclical fluctuations of animal numbers after 1930 reflect market conditions as well as forage productivity. Over this period, better management has reduced grazing pressure on native range by including the establishment of seeded pastures and, currently, by placing more emphasis on grazing rotations.

Farmers and ranchers with less than 47 beef cows raised about one-third of the cattle on about three-quarters of the farms in the Prairie Provinces (Table 3). Farmers or ranchers with more than 272 beef cows raised about one-twelfth of the cattle. Smaller farms usually use their range and pasture more efficiently than do larger farms. Generally, larger farms practice a more extensive system of grassland management, whereas small ones make greater use of improved pasture and crop residues.

In 1986, 13 600 000 ha of native range, 2 500 000 ha of seeded pasture, and 3 300 000 ha of hay and fodder (Table 4) provided the feed required for about 6 750 000 animal units in the Prairie Provinces. Also, an estimated 12% of the grazing was obtained from stubble fields and crop residues. Over the last 25 years, although available native range has decreased, improved pasture and hay areas have increased.

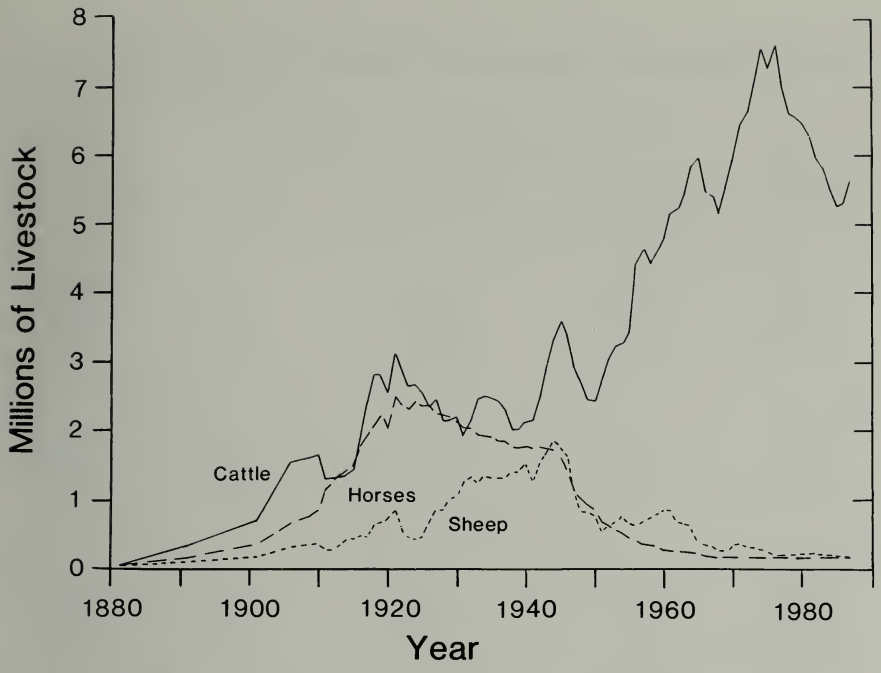

Fig. 3 Number of beef cattle, sheep, and horses in the Prairie Provinces, 1881–1988 (based on December–January inventory).

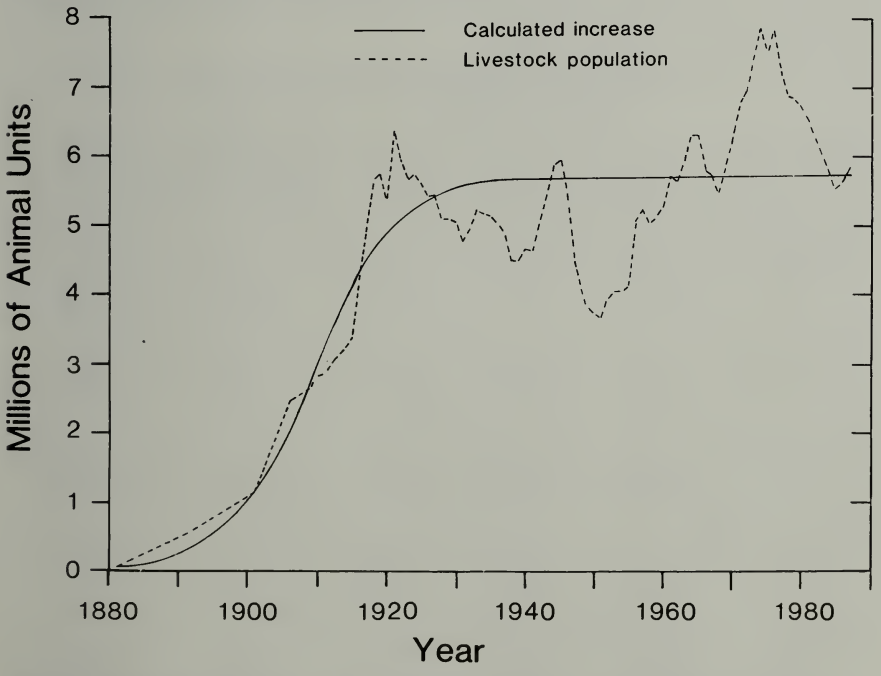

Fig. 4 Actual and calculated growth curves for the livestock population of the Prairie Provinces. Numbers of beef cattle, sheep, and horses are given in animal units (one animal unit equals 1.0 cow, 5.0 sheep, or 0.8 horse).

Table 2 Beef cattle, horses, and sheep in the Prairie Provinces

Livestock population	Numbers by province (in thousands)			Total number (thousands)
	Alberta	Saskatchewan	Manitoba	
Beef cattle				
1961	2522.8	1826.6	749.8	5099.2
1986	3702.9	1997.5	1049.8	6750.2
% change	+47	+ 9	+40	+32
Horses				
1961	113.2	110.3	50.8	274.3
1986	135.0	67.5	40.7	243.2
% change	+19	−35	−20	−11
Sheep				
1961	496.9	189.0	81.3	767.2
1986	179.1	53.3	24.7	257.1
% change	−64	−72	−70	−66

Table 3 Inventory of farms or ranches and beef cows for herds of various sizes, June 1986

Size of herd	Numbers by province (in thousands)			Total number (thousands)	% of total
	Alta.	Sask.	Man.		
Less than 48					
Farms	18.3	17.8	8.1	44.2	72.4
Cows	356.0	338.1	152.1	846.2	34.3
48–122					
Farms	7.4	4.1	2.4	13.9	22.7
Cows	544.0	291.6	167.2	1002.8	40.7
123–272					
Farms	1.7	0.6	0.3	2.6	4.2
Cows	279.0	96.5	50.1	425.6	17.3
More than 272					
Farms	0.3	0.1	0.0	0.4	0.7
Cows	142.5	39.6	8.8	190.9	7.7
Total					
Farms	27.7	22.6	10.8	61.1	100.0
Cows	1321.6	765.8	378.1	2465.5	100.0

Table 4 Areas of native range, improved pasture, and hay in the Prairie Provinces

Fodder type	Area (in thousand hectares)			Total area (000 ha)
	Alberta	Saskatchewan	Manitoba	
Native range				
1961	8014	7731	1908	17 653
1986	6498	5398	1714	13 610
% change	−19	−30	−10	−23
Improved pasture				
1961	676	564	291	1531
1986	1377	879	275	2531
% change	+104	+56	−5	+65
*Hay**				
1961	1254	638	474	2366
1986	1884	864	561	3309
% change	+50	+35	+18	+40

* Includes corn for silage, oat and barley hay, and other fodder crops.

VEGETATION ASSOCIATIONS

Five vegetation associations are found in the prairie range: Mixed Prairie, Fescue Prairie, True Prairie, Tall-grass Prairie, and Parkland. The grassland merges into Parkland at the western, northern, and eastern margins and at the higher elevations. Groves of aspen poplar distinguish the Parkland, and white spruce increases in abundance northward.

The grasslands differ in species composition and can be identified by their major dominants. Each vegetation type or vegetation association includes two or three dominant species. The main vegetation types that occur in the Mixed Prairie are *Stipa–Bouteloua*, *Stipa–Bouteloua–Agropyron*, *Stipa–Agropyron*, *Agropyron–Koeleria*, and *Bouteloua–Agropyron*. Fescue Prairie is dominated by a single species, *Festuca scabrella*. True Prairie is dominated by *Stipa–Sporobolus*, and Tall-grass Prairie by *Andropogon* species. Parkland contains grassland and aspen poplar forest.

Some grasses cure on the stem, retaining their form and a few of their nutrients for several months after growth ceases. Although cured grasses contain little crude protein or phosphorus, they do contain high levels of digestible carbohydrates. Many grasses of the

Mixed and Fescue prairies cure, whereas few species of the True and Tall-grass prairies do.

MIXED PRAIRIE

Stipa–Bouteloua type

The *Stipa–Bouteloua* vegetation occurs on soils of medium texture in the drier parts of the Brown soil zone. This type also occurs on soils of coarser texture in the Dark Brown soil zone and on sandy loam Solonetzic soils. The type is found where average annual precipitation is 250–350 mm and the precipitation-to-evaporation ratio is less than 0.4. These dry conditions favor the growth of short grasses. Therefore, this grassland is commonly called the Shortgrass Plains, and experience has shown that it should be used as range.

Needle-and-thread and blue grama have the highest ground cover of the grasses on this type of Mixed Prairie and are dominant (Fig. 5*a*). Other grasses may dominate locally. Associated grasses are June grass, western wheat grass, and Sandberg's blue grass. Thread-leaved sedge is abundant on eroded sites and hillsides. Abundant forbs are moss phlox and little club-moss. Shrubs include pasture sage and silver sagebrush.

Little club-moss is an important constituent of the vegetation. Sometimes its ground cover exceeds all other species combined and may comprise 10–50% of the total. It provides no forage, but helps to prevent wind and water erosion and reduces the effects of trampling. Seedlings of grasses readily become established in club-moss stands during years of above-average precipitation but rarely in dry years.

Overgrazing of the *Stipa–Bouteloua* type reduces the amount of needle-and-thread, June grass, and western wheat grass. Blue grama, Sandberg's blue grass, low sedge, broomweed, plains prickly-pear, moss phlox, and pasture sage may increase.

Stipa–Bouteloua–Agropyron type

The *Stipa–Bouteloua–Agropyron* (Fig. 5*b*) type occurs on medium-textured soils developed on undifferentiated glacial till in the moister parts and north-facing slopes of the Brown soil zone and in the drier parts of the Dark Brown soil zone. This type is found where annual precipitation is less than 350 mm and the precipitation-to-evaporation ratio is about 0.5. Medium-tall grasses, or midgrasses, are more abundant than in the *Stipa–Bouteloua* type.

Needle-and-thread, northern porcupine grass, blue grama, and wheat grasses make up about 70% of the total vegetation. Other grasses are June grass, reed grasses, Sandberg's blue grass, and green needle grass. Low sedge is common. Associated forbs and shrubs are moss phlox, little club-moss, pasture sage, silver sagebrush, and roses.

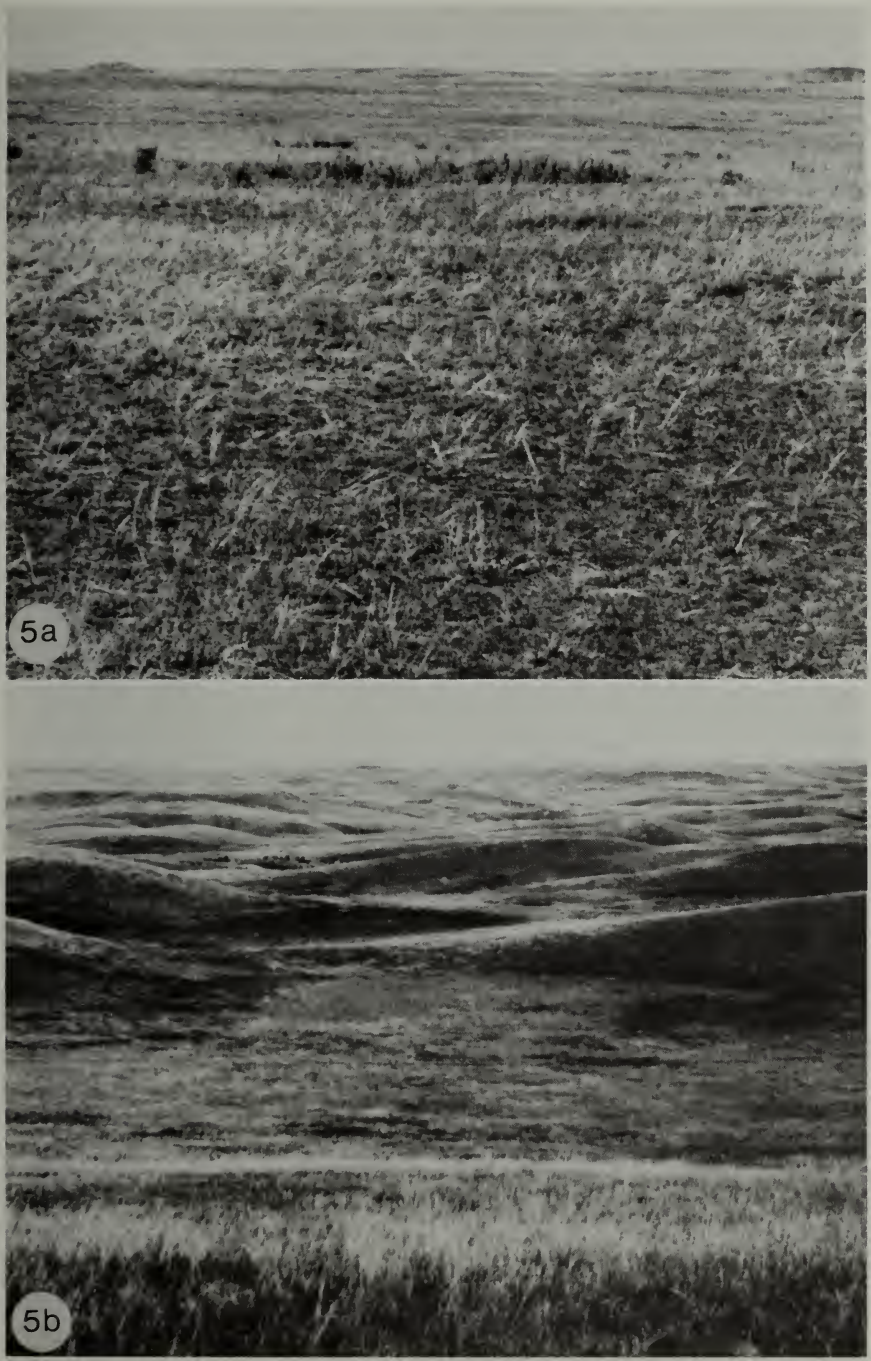

Fig. 5 (*a*) ***Stipa–Bouteloua*** **type of Mixed Prairie, commonly called the Shortgrass Plains.** (*b*) ***Stipa–Bouteloua–Agropyron*** **type.**

With proper management, the midgrasses can be maintained in the stand. The first evidence of overgrazing is the disappearance of the midgrasses and an increase in blue grama. As overgrazing progresses, pasture weeds increase in density, particularly pasture sage, moss phlox, broomweed, little club-moss, and prairie-crocus.

Stipa–Agropyron type

The *Stipa–Agropyron* type (Fig. 6*a*) occurs on well-developed soils of intermediate texture throughout most of the Dark Brown soil zone and on the adjacent, moister parts of the Brown soil zone. This type occupies rolling topography and sheltered, lower slopes of hills. It is usually transitional between the Mixed and Fescue prairies. It is found in areas where annual precipitation is 350–450 mm and the precipitation-to-evaporation ratio is 0.5–1.0.

Important species are northern porcupine grass, needle-and-thread, northern wheat grass, and western wheat grass. These species produce 75% of the total forage. Associated grasses are blue grama, June grass, Sandberg's blue grass, and green needle grass. Low sedge is common. Forbs and shrubs are moss phlox, little club-moss, prairie-crocus, roses, pasture sage, and western snowberry.

Low-growing species such as blue grama, June grass, Sandberg's blue grass, and low sedge, as well as little club-moss, pasture sage, and some shrubs, grow abundantly on overgrazed range. Most of this type is now farmed. Only the hilly, stony, sandy, or rough areas are used for grazing.

Agropyron–Koeleria type

The *Agropyron–Koeleria* type occurs in the Brown and Dark Brown soil zones on soils developed on uniform clay deposits that occupy the beds of former glacial lakes. The lacustrine clay soils are desirable for farmland, and only a few areas are used for grazing.

Dominant species are northern and western wheat grasses and June grass, which together produce about 75% of the forage. Green needle grass, Sandberg's blue grass, and low sedge occur in small amounts. Fewer forbs occur in this type than in others, but moss phlox and pasture sage are common. Winterfat, a forb, is characteristic, but blue grama and needle-and-thread are rare or absent. Wheat grasses, with their creeping roots, are adapted to the shrinking and cracking of clay soils. During drying, the tearing action separates young wheat grass plants from parent plants, whereas it destroys the crowns and roots of grasses with a bunch-type growth habit.

When they are overgrazed, the wheat grasses have less vigor, allowing low-growing plants such as June grass, Sandberg's blue grass, and low sedge to increase in abundance. Weedy forbs and shrubs, such as moss phlox, plains prickly-pear, broomweed, and pasture sage, increase also.

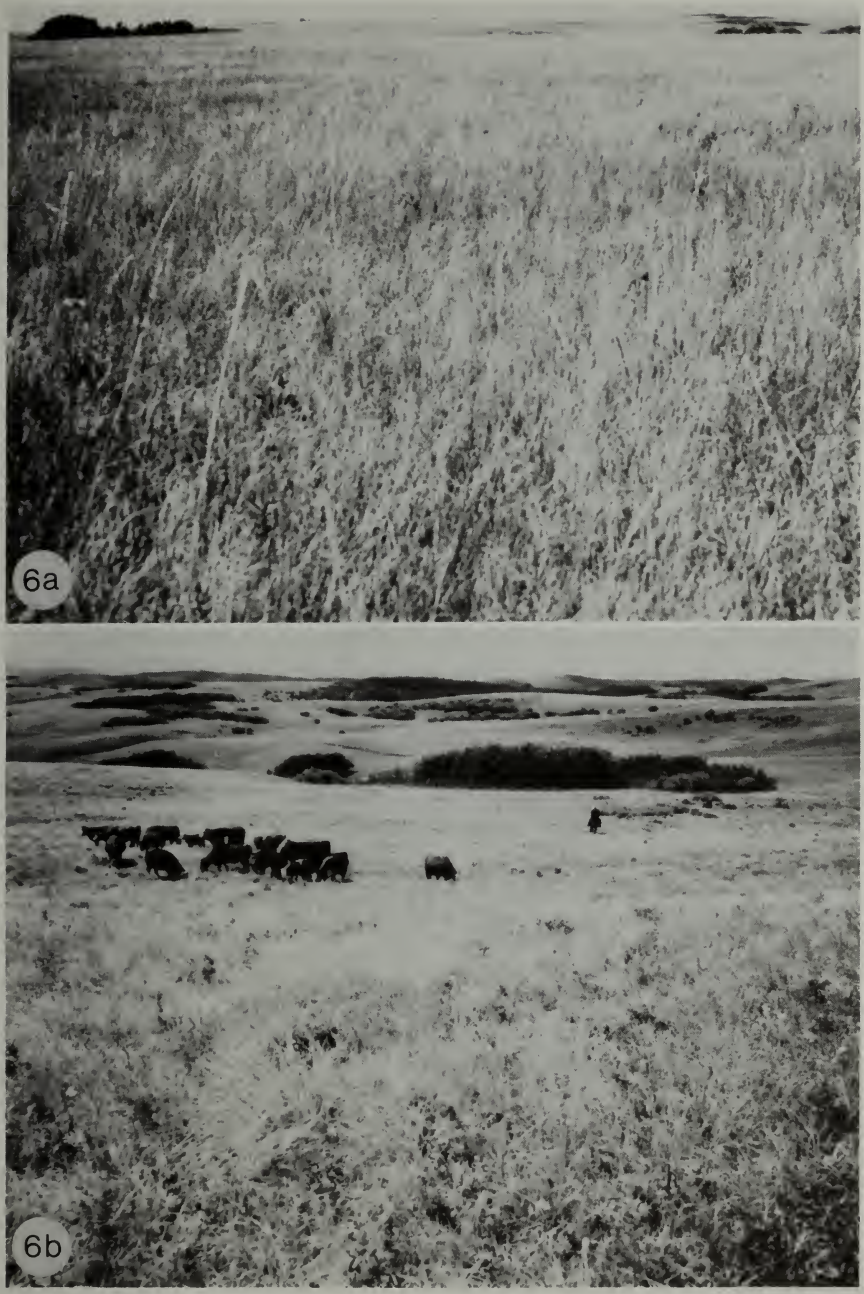

Fig. 6 (*a*) ***Stipa–Agropyron*** **type of Mixed Prairie, which is transitional between Mixed Prairie and Fescue Prairie. (*b*) Fescue Prairie in the foothills of the Rocky Mountains. The nearly continuous grass phase is shown; carrying capacity decreases as trees and shrubs encroach on the grassland.**

Bouteloua–Agropyron type

The *Bouteloua–Agropyron* type occurs on light- to heavy-textured Solonetzic soils in the Brown soil zone. During the Solonetzic process, the Ah horizon was removed in burnouts or eroded patches. The somewhat impervious subsoil that was left exposed is suited to the growth of wheat grasses. Where topsoil remains, blue grama is codominant with the wheat grasses.

Western and northern wheat grasses and blue grama provide about 70% of the forage. Associated grasses are needle-and-thread, June grass, Sandberg's blue grass, and plains reed grass. Forbs and shrubs are moss phlox, little club-moss, plains prickly-pear, silver sagebrush, pasture sage, winterfat, and salt-sage atriplex.

When overgrazed, the midgrasses decrease in abundance, whereas blue grama and Sandberg's blue grass increase. Low sedge, little club-moss, plains prickly-pear, and pasture sage increase under prolonged heavy grazing.

Other vegetation types

Throughout the Mixed Prairie, differences in climate, topography, soil depth, soil texture, and salinity, as well as presence or absence of a water table, are shown by the various types of vegetation (Table 5).

Table 5 Examples of important vegetation types and associated soil conditions

Vegetation type	Soil description
Needle-and-thread, blue grama, sand dropseed, sand grass, June grass, and northern porcupine grass	Upland; sandy loam soil
Needle-and-thread, sand grass, northern wheat grass, Canada wild rye, sand dropseed, Indian rice grass, and black chokecherry	Sandhill prairies; stabilized dune sands
Desert salt grass, foxtail barley, Nuttall's salt-meadow grass, alkali cord grass, and seaside arrow-grass	Sloughs and salt meadows; saline soils
Reed grasses, spangletop, manna grasses, prairie muhly, slender wheat grass, tufted hair grass, awned sedge, and slough grass	Sloughs and marshes; nonsaline soils
Western wheat grass, desert salt grass, silver sagebrush, and greasewood	Low-lying, level, poorly drained clay soils; saline soils

FESCUE PRAIRIE

Festuca scabrella type

The *Festuca scabrella* type occurs in the foothills of the Rocky Mountains (Fig. 6*b*), in the Cypress Hills, on other hilly areas, and over most of the Dark Brown, Black, and Gray Luvisol soil zones in Alberta and Saskatchewan. Only the stony, sandy, or hilly regions are used for grazing; the rest is farmed. This type is found where annual precipitation ranges from 450 to 550 mm and the precipitation-to-evaporation ratio is about 1.0.

This type is characterized by the presence of rough fescue, which may range from completely dominant along the northern fringe to codominant with northern porcupine grass along the southern edge.

Associated with rough fescue are Parry oat grass (in the southern foothills of the Rocky Mountains only), bluebunch fescue (=Idaho fescue), sheep fescue, wheat grasses, porcupine grass, northern porcupine grass, June grass, and wild oat grass. Forbs are prairie-crocus, silvery lupine, northern bedstraw, and field chickweed. Shrubs, which occur commonly, include shrubby cinquefoil, western snowberry, and roses.

Rough fescue is sensitive to summer grazing and disappears when it is grazed heavily. Therefore, where rough fescue is present in abundance, the range is in good condition. In the southern foothills of the Rocky Mountains, overgrazing results in the replacement of rough fescue by Parry oat grass, bluebunch fescue, wheat grasses, and June grass. Forbs and shrubs that increase include pussytoes, pasture sage, and shrubby cinquefoil. Elsewhere, rough fescue is replaced by wheat grasses, June grass, blue grasses, sedges, and many weeds.

TRUE PRAIRIE

Stipa–Sporobolus type

The *Stipa–Sporobolus* type occurs along the eastern edge of the Mixed Prairie. Most of the land of this type has been plowed and used for production of cereals and forages, except for the high-lime soils of the Interlake district of Manitoba and the sandy soils and areas of rough topography along the Manitoba Escarpment. This type has a high carrying capacity during the growing season. Few of the grasses cure on the stem, and nutritive value of the forage decreases after fall frosts.

TALL-GRASS PRAIRIE

Andropogon–Sorghastrum type

Most of this type is now cultivated for cereal, forage, and truck farming. Relict areas show that big bluestem, Indian grass, little

bluestem, prairie cord grass, porcupine grass, and switch grass were the dominant species. Forbs include northern bedstraw and prairie sage, and shrubs include western snowberry and roses.

PARKLAND

Parkland is grassland interspersed with groves of aspen poplar; grassland occupies the drier locations and aspen poplar occurs on the moister and more sheltered sites. Parkland is transitional, occurring between prairie and forest. It extends as a fringe along the foothills of the Rocky Mountains in southern Alberta, northeastward as a broad belt across south-central Alberta into Saskatchewan, then southeastward into southwestern Manitoba. The northern part of this vegetative type is mostly forest with occasional patches of grassland, whereas the southern part is mostly grassland with occasional groves of aspen poplar.

In Alberta and Saskatchewan, Parkland developed largely in Fescue Prairie. True Prairie and, to a lesser extent, Mixed and Tall-grass Prairie composed the cover in Manitoba before the invasion of aspen poplar. Parkland has evolved within about the last 150 years.

Tree cover changes gradually from west to east. In the foothills of the Rocky Mountains, lodgepole pine, white spruce, and Douglas fir succeed aspen poplar. Jack pine and balsam poplar are plentiful northward on upland sites, and black spruce grows in low boggy areas. Bur oak, balsam fir, and paper birch increase eastward. The grasses are largely those found in the associations from which Parkland developed, although hairy wild rye grass, slender wheat grass, awned wheat grass, and fringed brome grass are common throughout.

MANAGEMENT TO MAINTAIN YIELD

Range management is concerned mainly with planning and directing range use to obtain the maximum sustained animal production, as well as the conservation of the natural resources. The principles of range management are as follows:

- Balance the number of animals and the available forage supply.
- Distribute the animals evenly over the range.
- Control the periods of grazing and rest to manage and maintain the vegetation.
- Use the kinds of livestock most suited to the forage supply and the objectives of management.

In range management, an animal unit (AU) is one mature (450-kg) cow, with or without an unweaned calf, or the equivalent, based on average daily forage consumption of 12 kg of dry matter per day. An animal unit month (AUM) is the amount of feed or forage

required by an animal unit for 1 month. Because other classes or kinds of animals eat more or less feed per day than a 450-kg cow, calculations of stocking rates should take into account the difference in their forage requirements. The animal unit also may be adjusted to account for differences in size; for example, a 570-kg cow should represent 1.25 animal units. Animal unit equivalents commonly used in the Prairie Provinces are shown in Table 6.

Table 6 Animal unit equivalents

Class of animal	Animal unit equivalent
Cattle	
Mature cow, with or without unweaned calf	1.00
Weaned calves	0.50
Yearling heifers and steers	0.67
Bulls, 2 years and older	1.30
Horses	
Yearlings	0.75
2-year-olds	1.00
Mature light horses	1.30
Sheep	
Five ewes, with or without unweaned lambs	1.00
Five weaned lambs	0.50

CARRYING CAPACITY

Carrying capacity is a measure of the productivity of the range in terms of the number of hectares needed to supply feed for a mature beef cow or its equivalent. Carrying capacity may be calculated on a monthly or seasonal basis, depending on the productivity of the vegetation. Because vegetation types differ in productivity, they differ also in carrying capacity (Fig. 7).

Within an area dominated by one vegetation type, variations in soils, exposure, and drainage may result in sites with varying forage production because of resultant differences in species composition (Table 7). Also, within an area dominated by one vegetation type, differences in carrying capacity may be caused by variations in condition of vegetation or by climate.

Climatic variation, especially in precipitation, results in high year-to-year variability. At Manyberries, Alta., in the *Stipa–Bouteloua* type, 164 mm of rainfall between April and July are needed

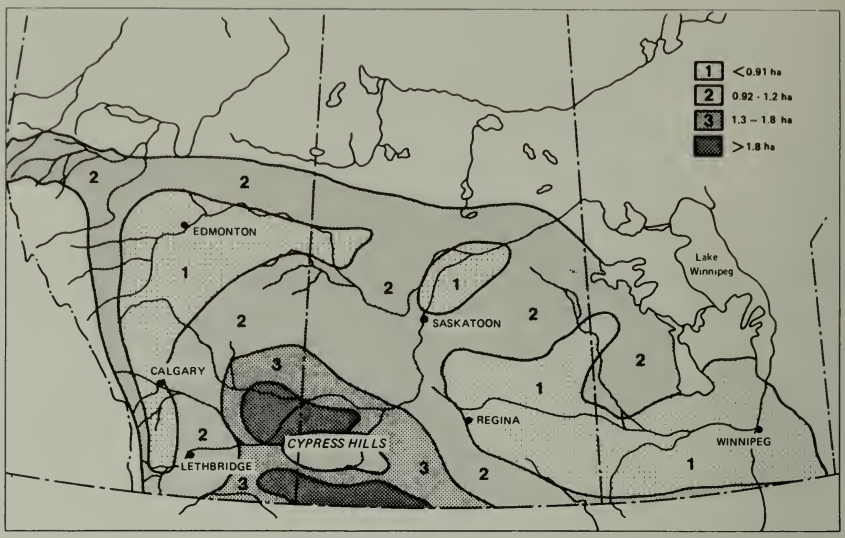

Fig. 7 Carrying capacities, in hectares per animal unit month, of the native grasslands of the Prairie Provinces.

to produce 384 kg/ha of forage. The rainfall during this period at Manyberries was 78 mm in 1961 and 419 mm in 1965; yields of dry matter were 96 and 736 kg/ha, respectively. Equations developed from these studies show the relationship between rainfall and yield (Table 8). May plus June rainfall and yield, April rainfall and yield, and soil moisture in the fall and the yield of grass in the succeeding year were found to be closely related.

Based on the regression equation for the *Stipa–Bouteloua–Agropyron* type (Table 8), grass yields in Swift Current, Sask., between 1888 and 1960 were 22–1850 kg/ha and averaged 538 kg/ha. In 27 of the 72 years, there was not enough growth to maintain the livestock load. During 23 years, there was enough grass to meet grazing needs and still provide a carry-over of about 40%. Growth exceeded livestock requirements in only 22 of the 72 years.

Carrying capacity can be determined by experience, by experimental grazing tests, or by estimating forage yield.

To estimate forage yield, the basal ground cover by each species is determined, using the point quadrat method of vegetation analysis, and these data are converted to kilograms of forage per hectare by means of forage yield tables. The sum of the species yields is an estimate of the average total forage yield. Average forage yields also can be determined by clipping sample plots over several years. To allow for carry-over, only 55% of the total yield is used in calculating the carrying capacity. A 450-kg cow (1 AU) needs about 355 kg of dry-matter feed per month. Therefore, the number of hectares needed

to provide feed for a 450-kg cow for 1 month is estimated by the following equation:

Carrying capacity (in hectares per animal unit month)
= 355/(0.55 × kilograms of dry matter per hectare)

Table 7 Percentage of basal ground cover, estimated yields, and estimated carrying capacities of three selected vegetation types

Plant species	Mixed Prairie				Fescue Prairie	
	Stipa–Bouteloua type		*Stipa–Bouteloua–Agropyron* type		*Festuca scabrella* type	
Grasses and Sedges						
Blue grama	4.1	7.3	1.8	2.0	–*	–
Needleandthread	0.7	1.3	1.4	0.4	–	–
Sandberg's blue grass	1.0	0.8	0.5		–	–
June grass	0.5	1.0	0.9	1.0	0.4	1.2
Western wheat grass	1.4	0.7	0.7	0.6	1.6	0.7
Sunloving sedge	0.5	1.7	1.5	1.6	1.3	2.2
Northern porcupine grass	–	–	1.9	2.4	1.6	0.1
Northern wheat grass	–	–	0.8	0.5	1.1	0.6
Rough fescue	–	–	0.5	1.6	3.2	4.6
Bluebunch fescue	–	–	–	–	0.1	1.1
Parry oat grass	–	–	–	–	–	5.0
Other grasses and sedges	0.4	1.1	1.1	0.4	2.1	1.2
Forbs and Shrubs						
Pasture sage	0.5	0.7	1.6	2.5	–	–
Moss phlox	0.2	0.5	0.4	0.2	–	–
Little clubmoss	6.5	8.7	3.2	4.1	0.8	–
Roses	–	–	0.2	0.1	0.9	0.2
Western snowberry	–	–	0.1	0.1	0.4	0.2
Threeflowered avens	–	–	–	–	0.6	0.3
Silvery lupine	–	–	–	–	0.1	0.4
Shrubby cinquefoil	–	–	–	–	0.2	1.3
Other forbs and shrubs	0.7	0.4	1.2	1.1	3.5	3.6
Estimated mean annual yield of dry matter (kg/ha)	350	450	560	730	900	1400
Carrying capacity (ha/AUM)	1.8	1.4	1.1	0.9	0.7	0.4

* Dash indicates that this plant is absent.

Table 8 Correlation coefficients (r) and regression equations (RE) showing relationship between rainfall (x, in mm) and grass yields (y, in kg/ha)

Period of rainfall	Vegetation type			
	Stipa–Bouteloua		*Stipa–Bouteloua–Agropyron*	
	r	RE	r	RE
April	0.40	$y = 314 + 2.5x$	0.03	*
May, June	0.58	$y = 187 + 2.0x$	0.74	$y = 1 + 5.2x$
April–July	0.74	$y = 72 + 1.9x$	0.90	$y = -269 + 4.6x$

* No value to the regression equation.

The carrying capacity of the *Stipa–Bouteloua* type of Mixed Prairie has been determined by grazing tests at Manyberries, Alta. Fields were stocked at three grazing rates: 16.2, 12.2, and 8.1 ha per animal unit for 7 months of summer grazing. The appropriate grazing capacity was slightly more than 12.2 ha per head. Subsequent grazing studies showed that 14.0 ha of range provided enough feed for a cow and calf over a 7-month grazing season with sufficient carry-over to maintain a stable vegetative cover. In addition, four grazing rates on Fescue Prairie were tested at Stavely, Alta.: 4.8, 3.6, 2.4, and 1.2 ha per animal unit for 6 months of summer grazing. Enough feed for a cow and calf, with sufficient carry-over, was provided by 3.6 ha of range.

Measurements of plant cover for various rates of grazing of Fescue Prairie showed that rough fescue was greatly reduced under heavy and very heavy grazing (Table 9). As the productive grasses disappeared, shrubs and weeds increased. These changes increased runoff, caused soil erosion, and reduced yields.

Carrying capacity is affected by the condition of the range. For example, the *Stipa–Bouteloua* type varied in carrying capacity from 1.5 to 3.8 ha per animal unit month, depending on the condition of the range (Table 10).

Carrying capacity is also reflected in livestock gain per hectare. Yields of animal products and actual gains from grazing tests in various locations in the Mixed and Fescue prairies are given in Table 11. The range of estimated gain per hectare allows for differences in the productivity of vegetation from place to place. When allowances are made for this variation in productivity, there is a close relationship between estimated and actual beef yields.

Table 9 Percentage basal ground cover for Fescue Prairie grazed at five rates for a 6-month summer season

Ground cover (%)	Rate of grazing				
	Un-grazed	Light	Moder-ate	Heavy	Very heavy
Parry oat grass	5.4	5.9	7.5	10.7	7.6
Rough fescue	10.1	9.1	4.8	1.8	0.5
Bluebunch fescue	1.2	1.2	1.3	2.8	2.6
Other grasses	1.2	0.5	0.9	0.5	0.7
Sedges	0.1	0.6	0.9	1.4	2.1
Forbs and shrubs	4.4	6.6	7.6	5.5	8.0
Total ground cover	22.9	24.0	23.3	22.7	21.5
Estimated yield of dry matter (kg/ha)	2100	2199	2171	1865	1170

Table 10 Carrying capacity (in hectares per animal unit) as influenced by condition of range

Vegetation type	Condition class			
	Excellent	Good	Fair	Poor
Stipa–Bouteloua	1.5	2.0	2.5	3.8
Stipa–Bouteloua–Agropyron	1.1	1.3	1.7	2.5
Agropyron–Koeleria	0.8	1.1	1.5	2.0
Stipa–Agropyron	0.8	1.0	1.3	1.7
Festuca scabrella	0.5	0.6	0.8	1.1

Table 11 Yields of animal products (in kilograms per hectare) in grazing tests and by estimate

Vegetation	In grazing tests			By estimate	
	Yearling ewes	Steers	Calves	Steers	Calves
Stipa–Bouteloua	9	18	11–16	15–19	11–18
Stipa–Bouteloua–Agropyron	–*	21	–	13–25	15–28
Festuca scabrella	–	–	39–45	26–44	28–50
Crested wheat grass	24	56	–	34–56	–
Russian wild rye grass	29	73	–	39–73	–

* Dash indicates that no data are available.

CARRY-OVER

Carry-over is the grass that is left on the ground at the end of the grazing season. On summer ranges, carry-over should be about 45% of the current year's growth of grass. Carry-over is easily seen and can be used as an indicator of range condition.

Carry-over is necessary because plants manufacture their own food in their green leaves. On summer ranges, about half the leaves should be left to manufacture food reserves, which are stored in the roots and crowns. These food reserves ensure continuing vigor, productivity, and longevity. Carry-over also traps snow and increases soil moisture, protects the crowns of plants, and allows for production of seed.

A carry-over of 45% every year is an impractical goal. Yields vary widely from year to year, and in a stable livestock operation, carry-over also varies widely. Range is not damaged by overuse during dry years when growth and carry-over are low, because the range will regain vigor during wet years, when growth and carry-over are high. For example, Mixed Prairie range was kept in good condition after 6 years of removing forage, with simulated grazing, to leave carry-over that ranged from 32 to 73% and averaged 49%. The rancher should aim at a rate of grazing that, over several years, will leave about 45% of the forage on the ground as carry-over.

Carry-over may not be as important on winter ranges as it is on summer ranges, because all the necessary food has already been stored in the roots and crowns before grazing starts. Therefore, stocking rates may be increased if grazing is limited to the winter season. However, on many ranges water limits forage production. Where this happens, carry-over is very important, regardless of when the range is grazed, because it produces litter that insulates the soil, reduces evaporation, and thus increases available moisture to the

plant. On the Mixed Prairie, removing all carry-over in fall resulted in a 60% reduction in subsequent forage yield. Carry-over can be less than 45% on seeded pastures, because seeded grasses can tolerate more foliage removal than can native grasses.

The value of carry-over has been shown by the clipping of rough fescue plants (Fig. 8). Tiller production, root weight, and forage production decreased as clipping intensities were increased (Table 12). Similar decreases occurred when needle-and-thread was clipped too closely and too frequently (Table 13).

Grazing may change the composition of a sward. In Mixed Prairie, needle-and-thread commonly becomes more abundant when a carry-over of about 45% or more is maintained. But low-yielding plants such as blue grama and thread-leaved sedge, or weedy plants such as pasture sage, become more abundant when grazing is intensified. The variation in percent composition of Mixed Prairie pastures after 10 years of grazing is shown in Table 14.

Table 12 Tillering and weight of roots and leaves of rough fescue clipped to three heights every 4 weeks for 20 weeks

Treatment	Number of tillers		Weight of 10 plants at end of test (g)	
	At start of test	At end of test	Roots	Leaves
Not clipped	87	431	147	202
Clipped to 12.5 cm	77	427	78	160
Clipped to 7.5 cm	81	192	30	59
Clipped to 3.8 cm	73	53	7	18

Table 13 Annual yields and percentage survival of needle-and-thread when clipped every month for four summers

Percentage clipped	Yield per 100 plants (g)	Plants living after 4 years (%)
20	97	100
40	96	100
60	82	100
80	72	77
100	60	50

Fig. 8 Sods of rough fescue clipped in the greenhouse at different heights every 4 weeks for 5 months. *Left to right*: Not clipped; clipped to 12.5, 7.5, and 3.8 cm. The decrease in food reserves is shown by the decrease in root volume as the intensity of clipping is increased.

Table 14 Percentage composition of Mixed Prairie swards at three grazing intensities

Species	Ungrazed (%)	Moderately grazed (%)	Overgrazed (%)
Wheat grasses	70	20	10
June grass	10	–*	–
Needle-and-thread	20	40	10
Blue grama	–	20	40
Thread-leaved sedge	–	–	20
Pasture sage	–	20	20

* Not present in measurable amounts.

GRAZING SEASON

Two concepts of the term *grazing season* are recognized. The first is concerned with the safety of the animals. Animals can graze safely from the time that the danger of spring storms is over until snow prevents foraging. This concept of a grazing season provides about 7–10 months in the southern districts, but less than 6 months at the northern limits of the Parkland. The second concept refers to the condition and vigor of the sward. Grazing in the spring should be deferred until the grasses are in the rapid phase of growth and are manufacturing and storing food. Therefore, the date to begin grazing varies from year to year. A more visible sign is when certain well-known plants are in bloom. For the Mixed Prairie, grazing can start when the golden-bean is in full flower, usually late in May. For the Fescue Prairie, grazing should start when the shooting-star flowers.

Grass species start growth at different times. In the Mixed Prairie, the order of growth is Sandberg's blue grass, June grass, western wheat grass, needle-and-thread, northern porcupine grass, and blue grama; the last species is about 6 weeks later than the first. In the Fescue Prairie, the order is rough fescue, Parry oat grass, bluebunch fescue, and wheat grasses; the wheat grasses are about 4 weeks later than the rough fescue. When grasslands are grazed too early in the spring, one or two species carry the load, and their stands and productive capacity are reduced. Growth of most grasses is slow until late May but is fairly fast during June (Fig. 9). Rapid growth begins when the soil temperature at 15 cm below the surface reaches 10–13°C. Crested wheat grass and Russian wild rye grass start to grow about 3 weeks earlier in spring than do native grasses and they grow at a much more rapid rate.

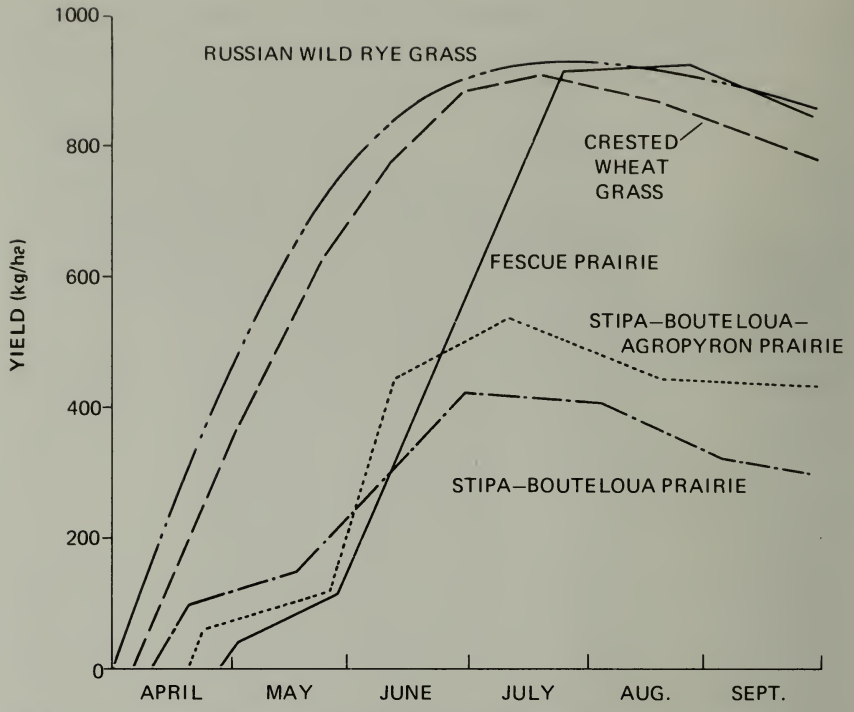

Fig. 9 Average yields of dry matter per hectare from five types of pasture.

On Mixed Prairie, the yield of native forage is greater the longer grazing is delayed in May and June. Simulated grazing tests started in late April, late May, or late June showed that yield was highest when clipping was delayed until late June (Fig. 10).

GRAZING METHODS

Ranchers can use one of several grazing methods, depending on their own requirements. They can use two main fields, one for summer and the other for winter; subdivide the summer range into two fields and graze each field in rotation in a spring–summer and a summer–fall system; divide the summer range into three fields and use each for about one-third of the grazing season; or divide the range into four or more fields and graze one field while others are left ungrazed for part or all of the growing season.

Some of these systems have been studied in grazing tests. Results show that one field grazed continuously produces animal weight gain as much as or more than two or three fields grazed in rotation at the same rate of stocking. The results were similar on Fescue Prairie, Mixed Prairie, and grass–alfalfa pastures in the Mixed Prairie region (Table 15). However, rotational grazing improves the grass cover because the plants are allowed to set seed and maintain food reserves.

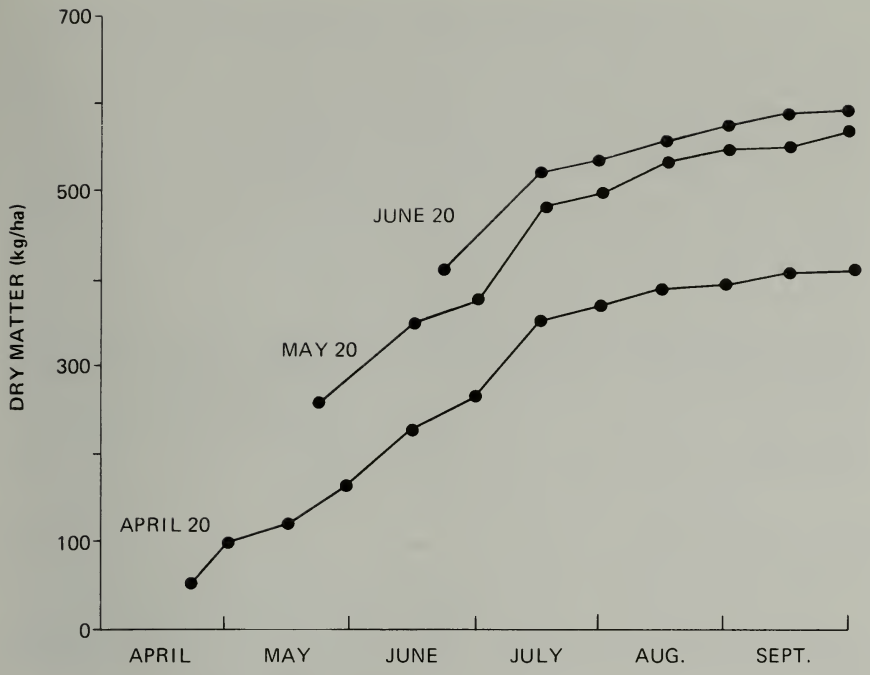

Fig. 10 Average cumulative yields of Mixed Prairie when clipping at 2-week intervals was started on three dates, April 20, May 20, and June 20.

Table 15 Comparison of continuous grazing and three-field deferred rotational grazing

Pasture and stock	Liveweight gain (kg/ha)		Grass cover (%)	
	Continuous grazing	Deferred rotation	Continuous grazing	Deferred rotation
*Mixed Prairie**				
Steers	18	17	7.2	7.4
Calves	15	13	7.4	8.2
Yearling ewes	9	–†	10.1	–
Grass–alfalfa pasture‡				
Yearling ewes	56	47	7.3	7.6

* Manyberries, Alta.

† Dash indicates that no data are available.

‡ Swift Current, Sask.

A test on Mixed Prairie showed the value of grazing crested wheat grass and native range in a complementary system. Crested wheat grass was grazed until late June, and native range from late June to mid October. This system carried 35% more animals and produced 6% more daily gain per steer than continuous grazing of native range from May to October. The complementary grazing system resulted in an increased liveweight gain of 43%. Also, the continuously grazed native range was grazed too heavily, but the native range that was protected until late June showed no sign of overuse.

Other tests with complementary grazing systems showed that crested wheat grass may be used until mid June or later, native range from mid June until mid September, and Russian wild rye grass from mid September until November 1. This grazing sequence on Mixed Prairie can be followed by using Altai wild rye grass for 2 months or longer after November 1. Liveweight production can be doubled by using 20% of the grazing area in seeded pasture.

FALL PASTURE

Native grasses are low in protein and phosphorus and high in carbohydrates during the fall. Ranchers overcome the lack of nutritive balance by pasturing cattle on annual cover crops, feeding protein supplements, or providing grass–legume pastures.

A mixture of Russian wild rye grass and alfalfa provides good pasture in the fall in the Brown and Dark Brown soil zones. Fall gains of yearling steers grazed on Russian wild rye–alfalfa were 0.6 kg per steer per day and, on Mixed Prairie range, 0.3 kg per steer per day.

Results of a grazing test at Manyberries, Alta., showed that Russian wild rye pasture doubled the live weight gain obtained on adjacent native range. The yearling ewes grazed the seeded pasture for 2.5–3 months in the fall, after mid August.

In the Fescue and True prairies and in the Parkland, red fescue, smooth brome, meadow brome grass, or intermediate or pubescent wheat grasses mixed with a legume are the best pasture crops to complement native range.

PASTURE RESERVES

Year-round feed reserves are needed. For the most practical means of ensuring feed reserves during spring and summer, maintain the correct carry-over, use moderate rates of stocking, defer grazing in spring, and, especially in the Brown and Dark Brown soil zones, use crested wheat grass or Russian wild rye grass for early season pasture and Russian wild rye grass or Altai wild rye grass for late season and winter pasture.

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COMMON AND BOTANICAL NAMES OF PLANTS

Grasses

alkali cord grass	*Spartina gracilis* Trin.
Altai wild rye grass	*Elymus angustus* Trin.
awned wheat grass	*Agropyron trachycaulum* var. *unilaterale* (Cassidy) Malte
big bluestem	*Andropogon gerardi* Vitm.
bluebunch fescue (= Idaho fescue)	*Festuca idahoensis* Elmer
blue grama	*Bouteloua gracilis* (H.B.K.) Lag.
blue grasses	*Poa* spp.
Canada wild rye	*Elymus canadensis* L.
crested wheat grass	*Agropyron cristatum* (L.) Gaertn.
desert salt grass	*Distichlis stricta* (Torr.) Rydb.
foxtail barley	*Hordeum jubatum* L.
fringed brome grass	*Bromus ciliatus* L.
green needle grass	*Stipa viridula* Trin.
hairy wild rye grass	*Elymus innovatus* Beal
Indian grass	*Sorghastrum nutans* (L.) Nash
Indian rice grass	*Oryzopsis hymenoides* (Roem. & Schult.) Ricker
intermediate wheat grass	*Agropyron intermedium* (Host) Beauv.
June grass	*Koeleria cristata* (L.) Pers.
little bluestem	*Andropogon scoparius* Michx.
manna grasses	*Glyceria* spp.
meadow brome grass	*Bromus biebersteinii* Roem. & Schult.
needle-and-thread	*Stipa comata* Trin. & Rupr.
northern porcupine grass	*Stipa spartea* Trin. var. *curtiseta* Hitchc.
northern wheat grass	*Agropyron dasystachyum* (Hook.) Scribn.
Nuttall's salt-meadow grass	*Puccinellia nuttalliana* (Schult.) A.S. Hitchc.
Parry oat grass	*Danthonia parryi* Scribn.
plains reed grass	*Calamagrostis montanensis* Scribn.
porcupine grass	*Stipa spartea* Trin.
prairie cord grass	*Spartina pectinata* Link
prairie muhly	*Muhlenbergia cuspidata* (Torr.) Rydb.
pubescent wheat grass	*Agropyron trichophorum* (Link) K. Richt.
red fescue	*Festuca rubra* L.
reed grasses	*Calamagrostis* spp.

rough fescue	*Festuca scabrella* Torr.
Russian wild rye grass	*Elymus junceus* Fisch.
Sandberg's blue grass	*Poa sandbergii* Vasey
sand dropseed	*Sporobolus cryptandrus* (Torr.) A. Gray
sand grass	*Calamovilfa longifolia* (Hook.) Scribn.
sheep fescue	*Festuca ovina* L.
slender wheat grass	*Agropyron trachycaulum* (Link) Malte var. *trachycaulum*
slough grass	*Beckmannia syzigachne* (Steud.) Fern.
smooth brome	*Bromus inermis* Leyss.
spangletop	*Scolochloa festucacea* (Willd.) Link
switch grass	*Panicum virgatum* L.
tufted hair grass	*Deschampsia caespitosa* (L.) Beauv.
western wheat grass	*Agropyron smithii* Rydb.
wild oat grass	*Danthonia intermedia* Vasey

Sedges

awned sedge	*Carex atherodes* Spreng.
low sedge	*Carex stenophylla* Wahlenb. ssp. *eleocharis* (Bailey) Hult.
sun-loving sedge	*Carex pensylvanica* Lam.
thread-leaved sedge	*Carex filifolia* Nutt.

Forbs, shrubs, and trees

alfalfa	*Medicago sativa* L.
alsike clover	*Trifolium hybridum* L.
aspen poplar	*Populus tremuloides* Michx.
balsam fir	*Abies balsamea* (L.) Mill.
balsam poplar	*Populus balsamifera* L.
black chokecherry	*Prunus virginiana* L. var. *melanocarpa* (A. Nels.) Sarg.
black spruce	*Picea mariana* (Mill.) BSP.
broomweed	*Gutierrezia diversifolia* Greene
bur oak	*Quercus macrocarpa* Michx.
Douglas fir	*Pseudotsuga menziesii* (Mirb.) Franco
field chickweed	*Cerastium arvense* L.
golden-bean	*Thermopsis rhombifolia* (Nutt.) Richards.
greasewood	*Sarcobatus vermiculatus* (Hook.) Torr.
jack pine	*Pinus banksiana* Lamb.

little club-moss	*Selaginella densa* Rydb.
lodgepole pine	*Pinus contorta* Loud. var. *latifolia* Engelm.
moss phlox	*Phlox hoodii* Richards.
northern bedstraw	*Galium boreale* L.
paper birch	*Betula papyrifera* Marsh.
pasture sage	*Artemisia frigida* Willd.
plains prickly-pear	*Opuntia polyacantha* Haw.
prairie-crocus	*Anemone patens* L. var. *wolfgangiana* (Bess.) Koch
prairie sage	*Artemisia ludoviciana* Nutt. var. *gnaphalodes* (Nutt.) T. & G.
pussytoes	*Antennaria* spp.
roses	*Rosa* spp.
salt-sage atriplex	*Atriplex nuttallii* S. Wats.
seaside arrow-grass	*Triglochin maritima* L.
shooting-star	*Dodecatheon conjugens* Greene
shrubby cinquefoil	*Potentilla fruticosa* L.
silver sagebrush	*Artemisia cana* Pursh
silvery lupine	*Lupinus argenteus* Pursh
three-flowered avens	*Geum triflorum* Pursh
western snowberry	*Symphoricarpos occidentalis* Hook.
white spruce	*Picea glauca* (Moench) Voss
winterfat	*Eurotia lanata* (Pursh) Moq.